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Evaluation of Faba bean (*Vicia faba* L.) varieties against chocolate spot (*Botrytis fabae*) in North Gondar, Ethiopia

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Faba bean (*Vicia fabae* L.) is one of the earliest domesticated food legumes in the world, probably in the late Neolithic period. The crop is also called by several local names (broad bean, horse bean and field bean). The wild progenitor and the exact origin of faba bean still remain unknown. Cultivated faba bean is mainly used as human food in developing and as animal feed in industrialized countries. The objective of this study is to evaluate and identify adaptive, high-yielding and disease resistant Fababean varieties under rain fed condition. Nine improved Faba bean varieties including local check were evaluated for their adaptation and yield in debark and dabat district under rain fed condition during 2012 and 2013 main cropping season. The varieties were planted in 3 replications using RCBD design. Combined Analysis of variance result showed that there were significant differences observed on all parameters. Based on maturity data Obsie and Motie are early type and Hachalu is the late ones, the largest treatment in height (129 cm), resistance to disease (3.4), largest hundred seed weight (90.08) and the highest yield (2429.5 kg/ha) were obtained on varieties Hachalu. So, variety Hachalu is best fits to the agro-ecology by providing reasonable yield advantage.

Key words: Faba bean, cultivars, production, yield.

INTRODUCTION

Faba beans, one of the oldest domesticated food legumes have been cultivated for at least 5,000 years. Their exact geographical origin is unknown, although Central Asia and the Mediterranean region have been proposed as possible centres (Metayer, 2004). Existing wild species are similar in appearance to the cultivated plant, but genetic analyses have shown that the wild types have a different number of chromosomes. Field trials to cross the wild and cultivated species have been unsuccessful (Mussa et al., 2008).

According to the United Nations Food and Agriculture Organization (FAO, 2014), China is currently the world's leading producer, accounting for approximately 60% of the total. Other important production regions are northern Europe, the Mediterranean, the Nile Valley, Ethiopia, Central and East Asia, Oceania and the Americas

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(Salunkhe and Kadam, 1989).

Faba is an annual herbaceous plant with coarse hollow stems that can reach heights of two meters. It has large pinnate leaves, consisting of two to six leaflets. It is mainly pollinated by bumblebees. White flowers with purple markings form in clusters of one to five, and one to four pods usually develop from each flower cluster. Up to 30 cm in length, each pod contains from three to twelve seeds. The plant also has a thick tap root up to one meter long with numerous lateral roots. Faba beans need a cool season for best growth and are usually planted as a winter annual in subtropical or warm temperate areas. They can tolerate a wide range of soil types and pH, but grow best in loamy soils. They need moderate amounts of water. Depending on growing conditions, it takes about four or five months for the pods to mature enough for the seeds to be harvested (Mussa et al., 2008; Macleod and Sweetingham, 1999).

Faba beans are commonly eaten for breakfast in the Middle East, the Mediterranean region, China and Ethiopia. They are used in soups and stews, and a paste made of ground beans is deep-fried with vegetables and spices (known as 'falafel' in Lebanon). In India, the seeds are roasted and eaten like peanuts. Faba beans are also roasted and ground for use as a coffee extender. Fava is also used as cover crop and for animal forage. The plants are large and produce large amounts of biomass that can be tilled back into the soil as green manure. Straw from the plants is used in brick-making and as fuel in parts of Sudan and Ethiopia. Research is ongoing on the potential use of faba beans as a treatment in Parkinson's disease. People with Parkinson's disease are unable to manufacture dopamine, which serves as a chemical messenger in the brain and helps regulate important motor and cognitive functions. Faba beans are a source of levadopa, a precursor of dopamine. When taken orally, levadopa is absorbed into the blood stream and carried to the brain where it is converted into dopamine (Zohary and Hopf, 2000).

Faba beans contain between 20 and 40% protein, depending on the variety and the environmental conditions under which they are grown. As with most legumes, they are low fat and a good source of dietary fiber and B-complex vitamins. Fava beans can cause problems for a small percentage of people. Favism is an inherited condition in which a person lacks an enzyme called glucose-6-phosphate dehydrogenase (G6PD). This rare deficiency occurs mostly among people of Mediterranean, African, and Southeast Asian descent. The condition helps serve as a defense against malaria by reducing the amount of oxygen in red blood cells. However, for people with Favism, eating undercooked faba beans or breathing faba bean pollen can lead to a serious anemic condition. Faba beans are also higher than most beans in complex carbohydrates called oligosaccharides, which may cause gas and abdominal pains (Tafere et al., 2012).

Ethiopia is probably one of the primary centers of diversification for Faba bean. Although the small seeded-type of Ethiopia Fababeen is not well studied, there are some reports of tremendous diversity in protein content, chocolate spot and leaf rust resistance. Faba bean is produced in many region of Ethiopia. The major producing regions are Tigray, Gondar, Gojam, Wollega, wollo, Gamo Gofa and Shoa. In addition it is grown in the pockets in the rest of the country's high land and semi-highland regions with altitudes ranging from 1800 to 3000 m above sea level. Currently, the total area under cultivation is estimated to be 512,067 ha of land from which 6,108 453 quintals are produced (Sahile et al., 2008).

Faba bean is widely used for food and has high protein content. Due to its nitrogen fixing capacity it is used in crop rotation with the nationally important cereals crops like wheat, teff and barley. Even if North Gondar is one of the major producing areas in Faba bean, there is no improved varieties that give high yield and disease resistance. So, the aim of this study was to develop and adapt improved technologies to increase faba bean production and productivity in north Gondar and to develop disease resistance varieties.

MATERIALS AND METHODS

Description of experimental sites

The study area is located in the northwest part of Amhara National Regional State; North Gondar zone at debark and dabat werdas. The experimental site is located at about 70 to 100 km northeast of Gondar town. The altitude of the experimental site ranges from 2650 to 2890 m above mean sea level. Rainfall is seasonal, varying in depth, space and time. The mean maximum temperature of the area is about 27.80°C while the mean minimum temperature is about 9.03°C and the mean annual rainfall in the area is about 1052 mm, which is erratic and uneven in distribution (NMSA, 2009).

Experimental materials

Nine improved faba bean varieties (Bulga-70, Degaga, Gebelcho, Obsie, Tumsa, Mesay, Dosha, Motie and Hachalu) including the local variety (check) were evaluated for their adaptation and yield in 20011 and 2012 cropping seasons across Dabat and Debark districts. These varieties were improved varieties released by Holetta Agricultural Research Centre national yield trial (Table 1).

Experimental design

The experimental design was randomized complete block design (RCBD) with three replications. Each plot consisted of six rows spaced 40 cm × 5 m long. The plot area used was 8 m^2 (5 m × 1.6 m). A 1.5 m distance was maintained between replication at all locations. Date of plating was the same for all trials. Planting was made at same seed rate. 100 kg/ha DAP were applied at planting time. Weeding and other agronomic practices were carried out as per recommendations of respective locations. Neither herbicides nor insecticides were applied. Four middle rows were harvested, dried, threshed and cleaned for data collection.

Table 1. Faba bean cultivars character used during adaptation trials in Holeta Research Centre.

Variety	Production/ha			
	Released year	Date to maturity	On research field	On farmers field
For highland area				
CS20DK	1977	145-16®	20-40	15-30
Kusie 2-27-33	1979	135-15®	2®-35	15-25
Bulga-7®	1994	143-150	20-45	15-35
Holeta-2	2001	140-150	20-5®	15-35
For midland area				
NC-58	1978	118-132	20-40	15-35
Kasa	198®	12®-135	20-45	15-30
Mesaye	1995	12®-135	20-45	15-30
Tesfa	1995	125-135	20-40	15-35
Degaga	2002	116-135	25-50	20-45
Hachalu	2007	120-125	30-40	25-35
For waterloged black clay soil area				
Selalae	2002	95-153	18-32	10-23
Wayu	2002	98-155	22-33	10-23

Data collection

Data on seed yield, agronomic and disease traits were taken from the center of four middle rows of each plot. Days to heading and maturity were separately taken when 50 and 90% crop stands headed and matured, respectively. The days were calculated beginning from the date of sowing. Plant height (cm) was taken at full maturity from five randomly selected plants of the central rows measured from the ground level to the top of the plant. Yield data was recorded from clean and dried samples. Plot yields were converted to kilogram per hectare. Hundred seeds were counted and weighted. The disease severity of chocolate spot disease was recorded at the 75th day from sowing using the scale of Bernier et al. (1993), as follows: 1 = no disease symptoms or very small specks (highly resistant), 3 = few small disease lesions (resistance), 5 = some coalesced lesions, with some defoliation (moderately resistant), 7 = large coalesced sporulating lesions, 50% defoliation some dead plants (susceptible), 9 = extensive, heavy spourlation, stem gridling, blackening and death of more than 80% of plants (heavily susceptible). Then, combined analyses of variance were performed using data across locations.

RESULTS AND DISCUSSION

In Debark and Dabat districts Faba bean adaptation trial significance of mean squares due to difference source of variability in combined ones are presented in Table 2. Results revealed that the tested varieties differed significantly in combined analysis except pod per plant. Combined analysis result over locations elucidates that locations were significant or highly significant for all traits. Therefore, it could be concluded that locations significantly affected the performance of the tested faba bean varieties. And the interaction effect of variety with location showed insignificance except days to flowering, disease incidence and hundred seed weight.

The Mean performance for different traits of nine Faba bean varieties and one local check are given in Table 3. The measured field data provided empirical evidences that varieties faba bean for cropping system influenced the level of disease epidemics and amount of yield loss attributed to chocolate spot on local (susceptible) and moderately tolerant cultivar. The moderately tolerant cultivar, Hachalu, had better effect in reducing chocolate spot epidemics, increased seed yield and yield components, and higher economic benefits over the local cultivar.

The mean for days to flowering of tested varieties ranged from 61 days (Dosha) to 65 days (Gebelcho and Tumsa). Days to maturity for tested variety ranged from 127 days (Obsie and Motie) to 133 days (Hachalu) showing highly significance difference among the tested varieties. Early maturing varieties complete their life cycle in relatively shorter period. Thus, early maturing varieties have advantage over the late maturity ones in environments where rain begins late and ends early. Disease severity score of tasted varieties ranged from resistance variety Hachalu with a score of 3.4 to a susceptible one Bulga-70 with a score of 5.4.Plant height of the tested varieties ranged from the shortest Motie (99.38 cm) to the tallest Hachalu (129 cm). Hundred seed weight ranged from the smallest local check which posses 48.509 g to the largest Hachalu variety which posses 90.08 g showing highly significance difference among the tasted varieties. The highest yield were obtained on varieties Hachalu and Dosha which is 2429.5 and 2226.3 kg/ha respectively.

The productivity of faba bean in Ethiopia is far below its

Table 2. Mean squares of the parameters for Debark and Dabat district Faba bean adaptation trial.

Sources	df	DF	DM	DI	PH	PPP	SPP	HSW	YLD
LOC	3	763.14***	8044.07***	31.14***	3209.3***	420.9***	5.11***	1547.9***	3888559.5***
Rep	2	0.4^{ns}	28.9^{ns}	1.05^{ns}	388.7ns	3.9ns	0.3ns	5.2ns	368174.8ns
varieties	9	28.3***	58.24***	4.44***	902.2***	22.25***	0.37ns	2407.4***	1927769.4***
LOC*var	27	8.07***	22.8ns	1.07***	133.18ns	4.8ns	0.2ns	28.7**	311453.83ns
Error	78	1.6	16.19	0.229	100.45	4.6	0.16	11.77	355218.36
R^2		0.9	0.9	0.47	0.7	0.8	0.6	0.96	0.65
CV (%)		2.03	3.09	11.35	9.25	26.7	13.5	5.18	5.06

DF=Days to flowering, DM = Days to maturity, PH = plant height, PPP = pod per plant, SPP = seed per plant, HSW = hundred seed weight , YLD = yield.

Table 3. Mean performance of nine Faba bean varieties and one local check for yield and other agronomic characters.

Varieties	DF	DM	DI	PH	PPP	SPP	HSW	YLD
Bulga-70	62^{ef}	129^{bc}	5.4 ^{a}	101.2^{cde}	9^{ab}	2.95^{abc}	50.049^{f}	1479.4^{cde}
Degaga	64^{bc}	129^{bc}	4.16 ^{cd}	109.3^{bc}	8.9^{ab}	3.03^{abc}	57.75^{e}	1657.7^{cd}
Gebelcho	65^{a}	132^{a}	4.08^{cde}	103.1^{cde}	6.9^{cd}	2.7^{c}	78.343^{b}	1562.7^{cde}
Obsie	62^{f}	127^{c}	4.4^{c}	100.2^{de}	5.6^{d}	3.2^{a}	70.8^{d}	1247.7^{de}
Tumsa	65^{a}	132^{a}	3.58^{f}	111.6^{b}	8.9^{abc}	2.88^{bc}	74.017^{c}	1859.9^{bc}
Mesay	63de	129^{bc}	4.9^{b}	108.86^{bc}	8.9^{ab}	2.96^{abc}	48.851^{f}	1785.5^{c}
Dosha	61^{f}	132^{ab}	4de	111.9^{b}	8.25^{bc}	3.25^{a}	72.5^{cd}	2226.3^{ab}
Motie	62^{f}	127^{c}	4.4^{c}	99.38^{e}	6.9^{cd}	2.98^{abc}	70.5^{d}	1128.6^{e}
Hachalu	65^{ab}	133^{a}	3.4^{f}	129^{a}	7.3^{bcd}	3.15^{ab}	90.083^{a}	2429.5^{a}
Local	63^{cd}	130^{abc}	3.75^{ef}	107.75^{bcd}	10.3^{a}	2.76^{c}	48.509^{f}	1640.8^{cd}
MEAN	63	130	4.2	108.2	8.08	2.99	66.15	1701.8
CV	2.03	3.09	11.35	9.25	26.73	13.55	5.18	5.06
LSD	1.04	3.27	0.39	8.1	1.75	0.3	2.7894	438.83

DF = Days to flowering, DM = days to maturity, PH = plant height, PPP = pod per plant, SPP = seed per plant HSW = hundred seed weight, YLD = yield.

potential due to a number of factors. The biological limitations include inherently low grain yielding potential of the indigenous cultivars and susceptibility to biotic and abiotic stresses (Mussa et al., 2008). According to Mesele et al. (2013) the varieties Hachalu, Kuse, Tumsa, Mesay, Moti, Gebelcho, Walki, Nc-58 and local cultivar were suffered from the disease (highest AUDPC). Conversely, CS20DK, Degaga, Bulga-70, Tesfa and Kasa were rated moderately resistant and developed the least symptoms at all locations. Highly significant differences were observed for number of pods per plant, seed yield and hundred seed weight among varieties. This variation may have occurred due to the agroecological adaptation of the varieties. Factors such as phosphorous or potassium deficiency, water logging and excessive weed infestations may make plants more susceptible to diseases (Macleod and Sweetingham, 1999). According to Nigussie et al. (2008), some improved varieties were moderately resistant to moderately susceptible for most faba bean fungal diseases .Therefore, searching efficient means for controlling the foliar diseases is so urgent for improving faba bean yield and its components. Selection of resistant cultivars to foliar diseases is the appropriate mean to increase the yield of the crop.

Conclusion

Faba bean is a high value crop that fetches high income to farmers. Besides, it is an important rotation crop which farmers are using to restore the fertility of their plots. However, farmers are growing disease susceptible and low yielding Faba bean varieties. In addition to statically analysis with the participatory evaluation high yielding and disease resistant varieties were selected with the participation of farmers. Therefore, if farmers could grow varieties Hachalu which has a yield advantage than the

local variety, the highest seed weight for export purpose and resistance to disease could highly increase their income.

Conflict of Interest

The authors have not declared any conflict of interest.

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